Handmote: Hand Gesture Based Remote Control for Home Appliances

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Abstract - Controlling the home appliances and electronics gadgets through an Infrared remote control is now in general. But the same controlling tasks can be done more easily. Primary motive of proposing the new system of hand gesture remote control is to remove the need to look in to the hand held remote and to search for a specific key for specific function. This paper presents a novel system to control home appliances through hand gesture as a remote control device. The system will referred to as Handmote in this paper. It uses real time image processing for hand gesture recognition in infrared vision using Blobscanner [1] library and microcontroller development board , Arduino[2]. This paper proposes a possible solution to control the gadgets for physically challenged and blind people.

Keywords– gesture recognition, Hand gesture, Infrared vision, Java, Arduino, Human computer interaction

1. Introduction

Among the rising age of technology in the field of gesture recognition for hand gesture or human computer interaction many research are done. Here the Handmote is referred to as use of hand gesture recognition to control the home or office gadgets that are operated through an infrared remote control in general. Simple remote controlled gadgets can be operated to change a TV channel or to tune radio by finding the key on hand held remote control and pressing it. But in this paper author puts effort to control the same but using hand gesture. Simply a hand gesture or showing number of fingers TV channel can be changed or it can be On/Off . By showing a cross fingered gesture to the camera, TV can be muted, rotating the hand in clockwise or counter clockwise can change the volume level or TV channels.

II. Proposed Concept

There is a computer application designed in Java Processing[5] to have real time image processing. An infrared camera is giving images in infrared vision to the computer application. After processing the images and recognizing the hand gesture, decision data is send to a microcontroller hardware based on Arduino environment[2]. This hardware sends the data to the gadgets in same way as a remote control does for general use. Gesture recognition solutions can be divided regard to the type of gesture used for controlling a computer. Gesture can be considered as a change of the hand position (hand movement) in a particular time interval with a given velocity or as a change of the hand shape (forming ellipse with thumb and the index finger). Gesture that belong to the first group are typically called dynamic gestures while those from the second group are often referred to as static gesture.

Software

To implement the algorithm and its logic for run time image processing, a JAVA Processing environment [5] is used. Processing is a Java based programming structure. To process the images, an open source image processing library under GNL GPL v3 license named as Blobscanner processing library is used. Once the data or frame is taken from an infrared web camera. After having the image in software, code will find the hand based on skin detection algorithm. If nothing is available then system will be ideal but if hand part is detected then system will startimplementing the gesture recognition algorithm on the image to recognize the gesture.

There will be always a question of removing background noise to increase the probability of occurrence of correct recognition. But here Authors wants to propose a novel method for recognition environment. In the practice authors used an infrared camera and an infrared LED source to create bright beam of infrared light. This IR source is put just near to the camera in the direction of user's hand. Now whenever user will make a gesture, his hand comes near to camera. Hand will look more bright then other region of image just because camera is infrared visible. Once interested area is more brighter then background noise or unwanted part, it is easy to convert the image in gray-scale based on relative intensity of image. This setup is shown in figure 1.
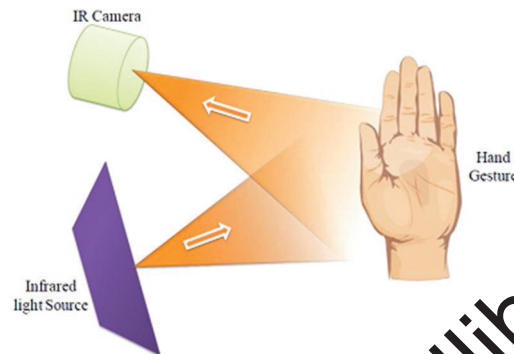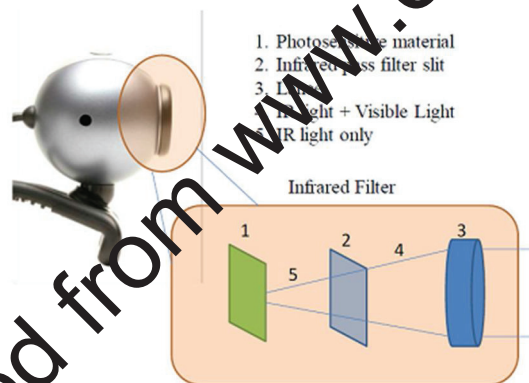
Figure 1. Camera and IR source setup

Figure 2, Filtering of IR light

Camera Hardware

Camera used in Handmote prototype is a simple Web-camera. The exact modification did to the camera is shown in figure 2. Light spectrum contains visible light and infrared light as well. Aim is to use infrared spectrum, thus the IR stop filter is replaced with IR pass filter, that is why camera will not see the visible spectrum but only the IR light reflected back from hand as explain in figure 1.Now this camera will give infrared region images of environment to the software application.

Algorithm

First step after taking a frame from camera is to track the hand based on skin detection algorithm using Blobscanner library. Next step is converting the image into binary form and then edge tracing. Once this much part is ready or hand is present in image than application search for gesture behavior by counting the number of fingers and its orientation. Angle between two successive finger gives useful flow to recognize

the hand gesture. Software application reference background frame stored in variable, and every time it compare with upcoming frames. This gives reliable recognition. Algorithm flow is shown in figure 3.
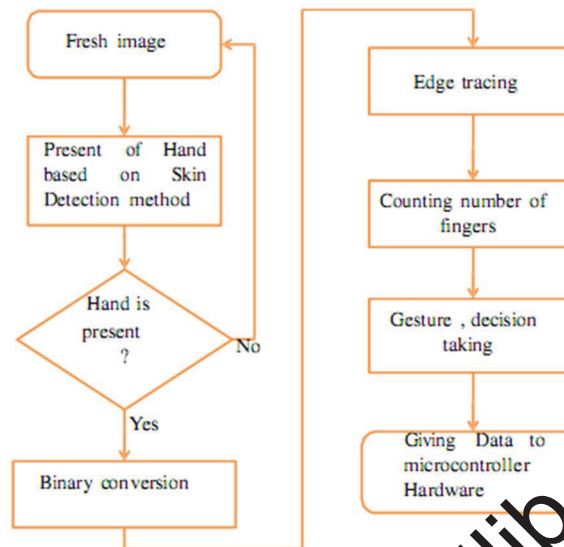

Figure 3 Application algorithm

Microcontroller Hardware

To decode the data coming from software application and send it to the electronic gadget, we used Arduino[2] development board based on microcontroller Atmega328 from ATMEL. Processor of hardware is running at the speed of 16MHz. The communication between software application and Arduino is based Serial port. Software code uses IBM COM port to send the data over serial port. The data rate for communication is 115,200 bauds/second. Based on the decision taken by software flow that which gesture is made, it will send a unique code related to a gesture. Now at hardware side, a program written on microcontroller will first receive the unique code, decode it and then transmit the related data to gadget by means of Infrared LED same as a remote control do.

In showcase of figure 4, picture A is showing binary converted image, picture B and C are showing edge tracing, picture D is showing counted number of fingers in image. Figure 4 shows final look of software.

Figure 4. Processing flow

III. Handmote, Proposed System

Handmote is a prototype model to control the electronics gadgets through hand gesture. It is a wearable device suggest as Hand + Remote, Handmote . It consist of a computer to run software application, an infrared camera to take images, Arduino development board to send commands to the gadgets, IR torch made up of number of IR LEDs to create bright infrared beam front of hand. At this development stage user need to wear the device and carry a laptop bag beside back. Tentative device is shown in figure 7.We integrated all modules on a wearable device, so that user can wear it and interact with gadgets just by making a hand gesture.

IR camera and Arduino board are powered up through USB port its self , rest the IR torch is using 12V battery supply to have very bright illumination. Question is, We always need to carry a laptop computer with it. Solution is briefed in section V.

Each remote control keys has its own unique code based on manufacturer, that is transmitted through modulated infrared light at 38 KHz at very low baud rate, 300-600 bauds/second. Here in our prototype, if user wants to turn ON the TV, he/she will simply make predefined gesture, software recognizes it and tells the microcontroller to send TURN-ON data to TV through IR LED. Only the TV would be able to decode it and respond to the same, rest gadgets will neglect it. As TV of Company A can only be operated through remote control by Company A. rest gadget will neglect it. Conclusively no modification at gadget side required, while in home automation system it is Data flow from software to Arduino then to the gadget is shown in Figure 5.
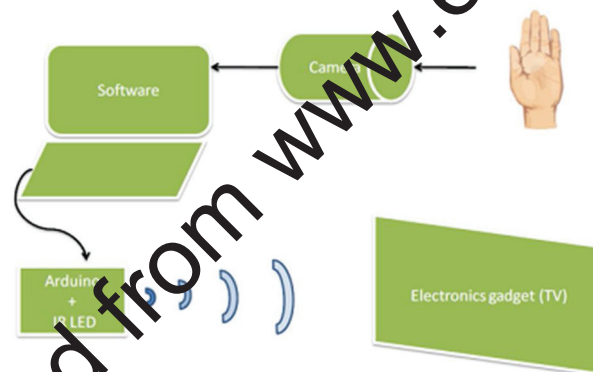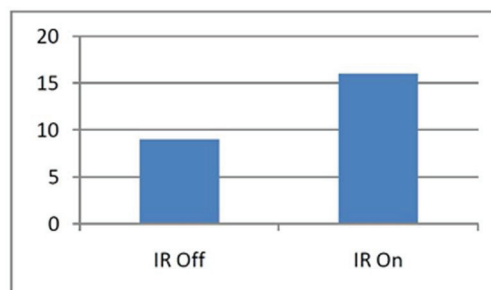

Figure 5 Processing flow

4. Testing and Experimental Results

We tested this Handmote device in both the conditions, 1. IR illumination off and 2. IR illumination on. An attractive result we got for 20 successive takes is here, It shows correctly recognized gesture out of 20.
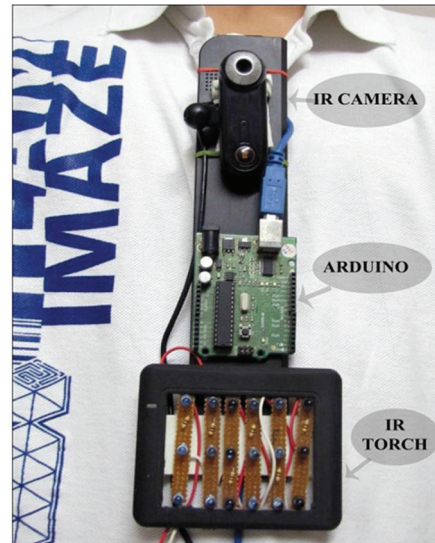
Figure 6, Wearable device

Use of Handmote device is not limited to Television On/Off. The device is tested on TV to change channels through up/down thumb gesture. Showing 4 fingers opened to power on/off TV. Even, Air conditioner temperature can be changed through gesture. We tested the device in car, suggesting that while driving the car user can change the tuned radio or song on music player. Here in practice we are replacing the traditional remote control with Handmote device so that, blind people or physically challenged people can operate the electronics appliances through simply a hand gesture, and no worry about which key press should do what ? Experimental testing of device is show in below images.
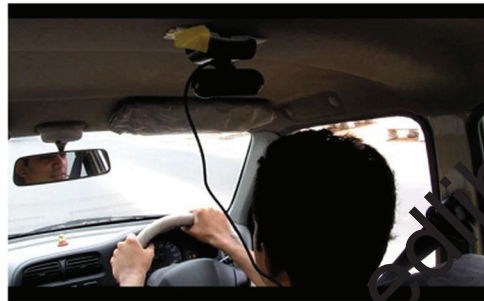

Testing at TV showroom-A[6].
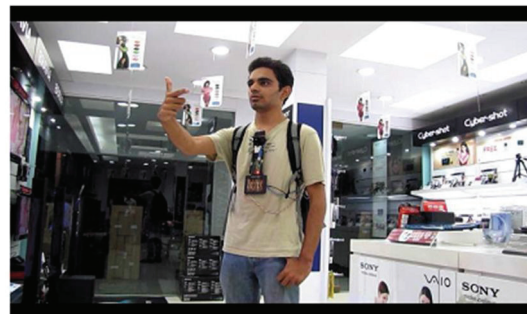
Testing at TV showroom-B[6]
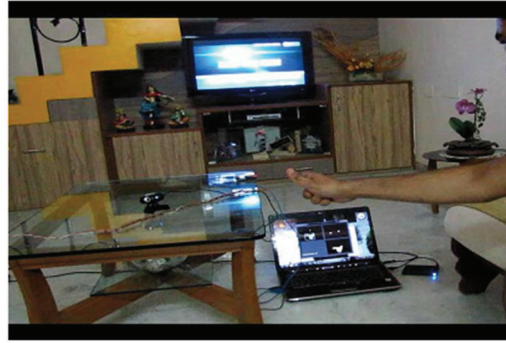
Testing of device for home appliances

Testing of stereo system for car use

V. Future Work and Acknowledgement

One disadvantage to this prototype is that, user should always keep a Laptop computer to run software application, however the application is written in JAVA processing environment, same software application can be made for Mobile phone device so that, processing power of software will be given by Mobile phone. Authors are working to develop same application in Android environment and making application open source, and available to all user so that Interaction between home gadgets and human become cost effective.

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